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Smoke Rings

A Reader's Problems

ONE of the justifications for the existence of THE MODEL ENGINEER is the service it can render to its readers in discussing, and usually solving, the practical difficulties which arise from time to time in the home workshop. While some of these difficulties are simple every-day jobs to the expert mechanic, they are often real posers to the amateur, and perhaps also to the more advanced worker who suffers from lack of appropriate equipment. So it is good that we should be able to ventilate these problems when they occur, and invite the co-operation of those who are in a position to furnish helpful advice to a fellow-reader. Here then are two problems recently submitted by a reader which I think are worthy of some discussion in our pages. One of these is a question on workshop methods, and the other on locomotive lubrication. I present them to the "brains trust" represented by our readers in the confident anticipation that some helpful advice will be forthcoming. Here is the first question :—"The most difficult, or one of the most difficult problems which meets me in the ordinary way, is that of securing a perfect 'velvet' fit without shake of pins in the corresponding eyes of such parts as link motions and the like. Loss of motion due to play is, of course, not permissible, and there is also the question of the satisfactory (case)-hardening of such pins and eyes, as well as the alternative solution of the problem involving the careful bushing with bronze of these small eyes and the use with the same of m.s. pins either in their natural state or case-hardened. The practicability of such minute bushes as would be involved would need careful thought. Would an article by Mr. Gentry, or perhaps by 'L.B.S.C.', on the general question raised, be possible? I am sure it would be appreciated by many readers." The second question runs as follows :—"This relates to the 'Midge.' I have always felt that the very important matter of lubrication was dismissed rather lightly in your series of articles dealing with this locomotive : if I remember rightly, the suggestion was that a displacement type lubricator should be used which to me, especially in the smaller sizes, has an uncertain feeling of lack of certainty or precision in what is after all a vital matter and one on the satisfactory functioning of which the whole performance of the engine may and, of course, does in fact, depend. Perhaps as an alternative a simple mechanical lubricator might be introduced which I think would be more in keeping with the carefully detailed thought devoted to the general design of this very interesting locomotive. I hope that perhaps you may be able to arrange for reference to be made to the points which I have indicated in our excellent weekly paper, THE MODEL ENGINEER." I shall be pleased if any of my readers are able to help this correspondent in connection with either of the two problems he has submitted for discussion.

A Notable Model Aircraft Display

AN exhibition of model aircraft and other objects of war-time interest has recently been held at the Plymouth Museum and Art Gallery in aid of the Lord Mayor's Services Welfare Fund. A very interesting feature of the show was a collection of 120 models of aircraft, all of which had been made by a schoolboy, Stanley Clapham, 14 years of age. The models were faithful miniatures of British, American, Russian, German, and Italian planes, and showed a variety of types such as fighters, bombers, and troop-carriers. They were all hand-painted by the young maker, and each carried the distinguishing mark of the country to which it belonged. I understand that Stanley Clapham's work is so true to the prototype, that he has been entrusted with a contract by the Government for the construction of models, a contract which he has just completed. I hear also that he has recently won a scholarship to the Kingsbridge Grammar School. My congratulations, Stanley—a fine achievement.

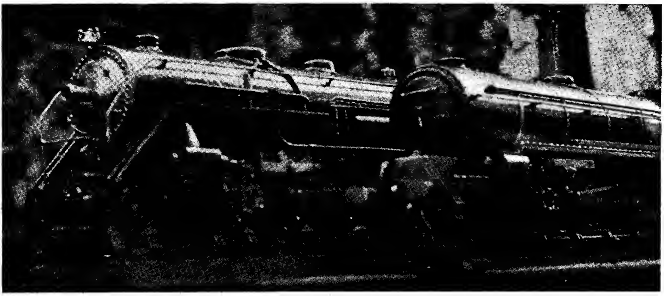
Leeds Lends a Hand

I AM pleased to hear from Mr. H. E. Stainthorpe, Hon. Secretary of the Leeds Model Railway and Engineering Society, that the members recently staged an exhibition of models at Lewis's Store under the direction of the *Yorkshire Evening News*. The show was in aid of the R.A.F. Benevolent Fund, and the sum of £65 10s. 10d. was collected for this admirable cause. Bravo, Leeds!

Models in Matchboxes

THE common everyday matchbox seems to present a challenge to the enthusiast for miniature work. What curiosity of construction can he fit inside it? Mr. Charles Needham, of Lees, near Worthing, has recently found one answer to this question; he fills his matchboxes with miniature buildings, and sells them in aid of war charities. A recent example of his work is a model of an historic inn, but more remarkable still is the interior of a six-roomed house, showing the six separate rooms each completely furnished, and all neatly fitted into the tray of one match-box. I have seen wireless receiving sets, and also model ships housed in this way. Doubtless other subjects will occur to those who feel the call of the curious and possess the neat-fingered craftsmanship necessary to achieve such remarkably delicate work.

Percival Marshall



"Allies" on Gauge "O"

By "L.B.S.C."

A FOLLOWER of these notes who resides on the western outskirts of London, and modestly signs himself "Web," has apparently been as busy as the little insects that make such things, to judge by the reproduced photo of his efforts! Our friend says he first built "Sir Morris de Cowley," the "O" gauge 4-6-2 I described years ago in the old "Live Steam" notes, and she proved very successful. Then, when the description of the American "O" gauge 4-6-4 "Josie" appeared, he set to work and built that one as well; and she, too, proved a winner. He soon found that this engine, having a bogie at either end, was far more flexible than "Sir Morris," and also he liked the Walschaerts valve gear in preference to "Sir Morris's" loose eccentrics, so conceived the idea of rebuilding the latter engine and putting a bit of "Josie" into it. This was done, and she now has a more flexible wheel-base, and Walschaerts gear, the latter being plainly visible in the picture.

The original trailing truck was taken off, and a boiler cradle made and attached to the main frames, to carry the firebox. This was made from $\frac{1}{8}$ in. by $\frac{1}{4}$ in. steel, laid flat and brazed at the corners, then bolted to the frames; a trailng truck something after the style of "Fayette's," only half the size, but spaced out to "Josie's" wheelbase, took the place of the original trailing truck, and the ashpan was fitted to the top of it. It fits up close to the cradle. The new valve gear was made to the dimensions given for "Josie," and fitted without any trouble. Our friend says, as to performance, there is nothing to comment about; you just get up steam, and away they go; which is, he adds, a bit of a difference to days gone by, when engines he built to other designs had to be continually altered and amended to get them to run at all. That made pleasant reading for your humble servant, because it has always been my aim to guarantee full satisfaction to anybody who "follows the words and music," and it is only by actual personal experience in locomotive building that such a guarantee is possible.

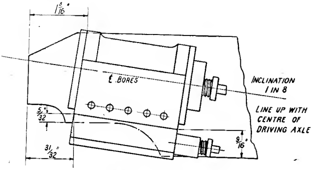
Talking about satisfaction, I have just heard from my friend who now has the tiny "County of Rutland," and he is delighted at the way this pocket edition of a Great Western locomotive performs. On the first run, he managed to get three of the tubes blocked up, but after that he broke up the coal into very small pieces (he is using Phurnod No. 3 nuts) and sifted all the dust out, and now has no trouble. He says there is certainly no half measures about the way she "chops 'em off"; and all he needs now is a long train of Great Western coaches, to give her something to pull. I thought somehow I'd put him on his mettle when I told him he would never be able to fire her! Incidentally, I can just imagine the smile on Mr. Maskelyne's face when he reads this, as he always believed that boilers never need be any bigger than "scale"; and when we do it on gauge "O," and on a big-cylindered, long-stroked engine of his own "pet" railway at that—well, enough said!

"MOLLY"

Valve Gear

I told you I hit up against a spot of bother with the valve gear for "Molly"; or rather, it was not in the gear itself, but in the means of transmitting the drive from the die-blocks in the links to the underneath offset valve spindles. This is how it was. On the big engine, the valve faces are vertical, the valves being between the cylinders, and the two valves are back to back, with the spindles driving them direct. I previously explained why we could not do this in the little engine, and in my "tentative re-arrangement" as we might call it, I thought to use a couple of rocking levers working in brackets attached to the motion-plate, pin the die blocks to the top of the levers, and connect the lower ends to the valve spindles by plain links. That

sounded O.K., as I've done similar jobs before; but when I came to get busy with my bits of cardboard, tin, pins and whatnot, and visualised the whole set-up, I saw at once two large-sized bluebottles in the syrup can. One was, that I would have to fit launch links, so that the eccentric-rod forks would not foul the rockers; and the second was, that it would not be possible to use the same lifting links and suspension as on the big engine. It is



Location of cylinders.

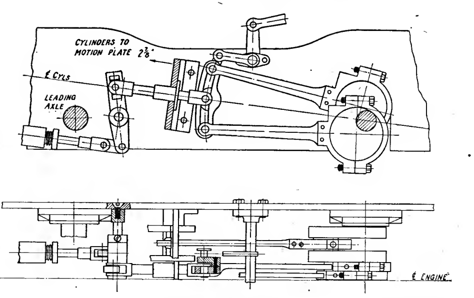
my aim, on this particular job, to keep to the design of the full-sized engine as far as possible in the detail work; and she has the usual locomotive links with top and bottom connections, and a single-pin suspension for the links, from a circular bracket at one side only.

Well, I wanted to retain these features, so I tried about half-a-dozen or so schemes and "wangles," and the one shown in the reproduced drawings seemed about the best of the lot, as it incorporates the same arrangement of intermediate valve spindle working in a long bush in the motion plate, as on the full-sized locomotive. The only difference is that, instead of the front end of the intermediate spindle driving the valve spindle direct, it actuates the upper end of the rocking lever which transmits its movement to the valve spindle below. Thus, the whole of the actual motion, viz. eccentrics and rods, links, dies, lifting gear and intermediate spindles, are as near as we can get to L.M.S. practice, consistent with strength and wear-resisting qualities. The eccentric rods are "scale" length, centre of strap to centre of pinholes in the forks, but they have a longer throw, as we are using my own port sizes which entail a longer valve travel. For the same reason the links are longer. On a little engine, there is no need for counterbalances on the weigh shaft, so I have left them off. The central circular lifting block, with its single pin on the outside of each link, is "all-present-and-correct-sergeant," ditto the single lifting links and arms on the reversing shaft.

For the rocker gear, I have copied Great Eastern practice, only it is turned upside down. Many of the G.E. engines with valves on top of the cylinders, driven by Stephenson link motion, had a rocking shaft almost exactly like the one shown here. As the intermediate spindle works in a straight line, and the upper end of the rocking lever describes an arc, we have to use a little die working in a slot at the end of the lever. This is easy enough to make and fit. I did think of the Continental sliding pin arrangement, but did not want to give Inspector Meticulous any encouragement to put a report in about being "unpatriotic," or some such complaint, and the old Great Eastern Railway was British to the core! At the lower end, by cutting $\frac{1}{8}$ in. off the length of valve spindle given in the cylinder drawings, and screwing on the fork again, we can space the pinholes in fork and rocking lever at $\frac{3}{8}$ in. centres, which allows for connecting them with a plain link. The elevation of the valve-gear shows the whole issue exactly as it is with the lever in mid-gear and the crank on front dead centre. The bodily swing of the expansion link, due to the advance of the eccentrics, has moved the upper end of the rocking lever over 5/32 in. off centre, and pulled out the valve spindle sufficiently to allow the valve to open the front port to lead.

The amount of intermediate spindle projecting beyond the motion plate bush, necessary for the full travel, plus the length of the fork, effectually put out of court any idea of bracketing the rocker shafts to the motion plate itself; and the only alternative was to mount them on a spindle running right across the frames, as I have done many a time when rebuilding $2\frac{1}{2}$-in. gauge engines made by the long defunct Sheffield firm, whose engineer took Harry Lauder's walking stick as a pattern for his direct-coupled eccentric rods. As luck would have it, the position of this spindle came out at 11/16 in. from the bottom of the frame, and exactly $\frac{7}{8}$ in. behind the leading axle centre, so that no subterfuge was necessary to dodge the leading hornblock. The back edge of this is $\frac{3}{4}$ in. from the centre of the leading axle, which gives us room for a rectangular bracket $\frac{1}{4}$ in. wide, and just long enough to take two $\frac{1}{8}$-in. screws, one above and one below the 3/16-in. spindle which is pushed into a hole in the bracket. The rocker bushes can either be made of steel, and bronze bushed, or made from solid bronze rod, the rocking levers being brazed or silver-soldered to them. The inner ends touch, and the outer ends may work against collars setscrewed to the spindle, to prevent any side movement of the bushes; this is not absolutely necessary, but it takes any side thrust away from the rocking levers and valve spindles.

The whole layout is as near as I could get to full-size practice, at the same time keeping the gear robust enough to stand up to wear without being clumsy, and taking into

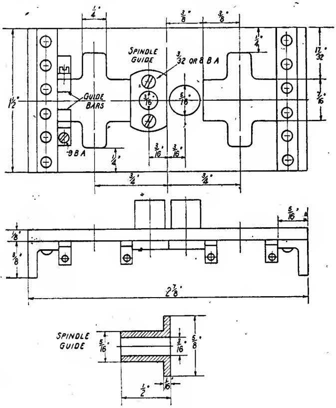


Valve-gear for "Molly."

account the alterations due to the underneath valves. I don't think anybody will have the slightest trouble in making the parts and erecting them; fully-detailed and dimensioned drawings of each part will follow as usual, all being well, and "wind and weather permitting."

Motion-Plate

This is the first item on the agenda, and is different from anything so far described in these notes, inasmuch as it supports eight guide bars and two intermediate valve spindles. By rights, it should be a casting; at the time of writing, there is nothing available, but—who can say in



Motion-plate.

these times of unexpected happenings?—maybe by the time you are ready to make and fit it, there may be some available. If anybody wants to make a pattern, the little brackets for attachment of the guide bars and the 1/2-in. bearings for the intermediate spindles to slide in, should be made integral with the casting, and the whole doings cast in gunmetal or bronze. The side flanges for attachment to frame should have strengthening ribs like a horn-block, and the top and bottom edges can be beaded, as in full-size practice. Might as well make a pretty job of it!

Failing a casting, build up the motion plate as follows. The plate itself is a piece of 1/8-in. steel, 2 7/8 in. long and 1 1/2 in. wide, nicely squared up to fit between frames. The shape and size of the openings for guide bars and connecting-rod clearance is shown in the sketch, and special care should be taken over the guide-bar corners, so that the bars are maintained in parallel position all ways. As the bars touch the motion plate on two sides only, instead of fitting into a channel like the two-bar type, some kind of support will be needed; and a little piece of 1/4-in. by 1/16-in. brass angle, 1/8 in. long, screwed or riveted to the plate over or under each bar, as shown in the sketch, is about the easiest way of providing it. A 9 B.A. screw passes through a No. 48 hole drilled in each piece of angle, and enters a tapped hole in the bar itself, the location of the holes in the bars being jigged off from those in the little brackets, with the motion-plate in position between the frames.

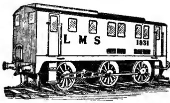
Valve Spindle Guides

Two guides or bearings are required for the intermediate valve spindles, and these may be made from bronze or gunmetal rod. On the horizontal centre-line of the motion-plate, at 3/16 in. each side of the vertical centre, drill a 1/8-in. pilot hole, and open it out to 5/16 in. If you drill the larger hole direct, the drill may wander a shade, put the bearings out of position, and prevent smooth and correct working of the whole motion; it is the little things that matter, as the motorist remarked when he pulled a tack out of his flat tyre. Eh? oh, just an ordinary black tack! To make the bearings, chuck a piece of 5/8-in. round rod in the three jaw; face, centre and drill down about 9/16 in. depth with No. 15 drill. Turn down 7/16 in. of the outside to 5/16 in. diameter, and part off at a full 1/2 in. from end. Reverse in chuck, take a skim off the face of the flange to true it up, then run a 3/16-in. parallel reamer through the hole. File the flange flat on opposite sides as shown in sketch, drill a couple of No. 41 holes in it, and countersink them, poke the bearing through the 5/16-in. hole in the motion plate, which it should fit tightly, and fix it with a couple of countersunk screws running into tapped holes in the motion plate.

The side flanges for attaching the motion plate to the frames are 1 1/2-in. lengths of 3/32-in. by 3/8-in. angle brass riveted to the plate by 1/16-in brass rivets as shown; but the side of the angle butting up against the plate must have 1/16 in. filed or milled off it, to prevent it fouling the guide bars and brackets. To erect the plate, place it between the frames 2 7/8 in. from the back of the cylinder block and parallel with the end of same; that is, at right angles to the centre line of motion, with flanges towards the back of the engine. Put a toolmaker's cramp at each side, over frame and angles, to keep the plate in position when correctly located, then run the No. 30 drill through the holes in frame, making countersinks on the angles. Follow up with No. 40, tap 1/8 in. or 5 B.A., and secure with countersunk screws. Put each guide bar in position, with its circular spigot in the correct hole in cylinder cover; jam it in place in its corner of the motion plate with a wooden wedge or any other convenient means, run a No. 48 drill through the hole in the bracket, and make a countersink on the bar. Follow up with No. 53 drill, tap 9 B.A., and secure with a cheese or hex-head screw, which must be filed off flush on inside of bar, so that the slippers will pass without getting scored or scratched. It is easiest to remove the bars for drilling and tapping; but mark each one so that they can always be replaced in proper order, if taken down for any purpose.

Cylinder-block Location

I find on checking over the frame drawing that I did not indicate the position of the cylinder block by dotted lines, as usual, so here is the correct location, see sketch. When the block is adjusted correctly, put a big clamp over the frames to stop it from slipping, then make countersinks on the sides of it with a No. 30 drill through the holes in the frames. Remove, drill the marked places No. 40, and tap either 1/8 in. or 5 B.A. Replace block, and secure with countersunk screws; or, if you like, put hex-headed ones in where the screwholes are clear of the leading wheel.



1831 . . .

★A $3\frac{1}{2}$-in. gauge I.C. Engine-driven Locomotive

By Edgar T. Westbury

THE timing diagram gives the timing for a single cylinder only, and thus when one pair of cams has been timed up, it must be shifted through a distance equal to the phase difference in the timing of the respective cylinders—in this case, one revolution of the crankshaft, or 180 degrees of camshaft movement. To ensure accuracy in shifting the division plate the required amount, the "TDC 1" position must be aligned with the index, and the shaft locked in position; then the plate is loosened, and turned *on the shaft* to position "TDC 2," where it is again secured, and the timing of the second pair of cams carried out. When all cams have been timed, their relative positions, looking from the timing end of the shaft, are as shown in Fig. 69. It will be seen that the two exhaust cams, 1 and 4, are diametrically opposite each other, and the same applies to the inlet cams 2 and 3.

The most satisfactory method of securing the cams on the shaft is by means of 1/16-in. taper pins, which should be very carefully fitted to holes taper-broached right through the cam bosses and the shaft. After final assembly, the pins should be driven in tightly, cut off almost flush with the bosses, and lightly riveted over to prevent risk of loosening.

A Simple Cam-Turning Jig

In the event of the cams being formed integrally with the solid camshaft, it is possible to produce them by hand filing as in the case of individual cams, but their relative angular positions must be very carefully measured in conformity with the diagram, and this will probably be found the most difficult part of the job. It is, therefore, better, and in my opinion easier, to machine them, and as the cam flanks—which are the most important part of the contour—are arcs of circles, it is possible to do this by an eccentric turning operation. I have described methods of doing this on two or three previous occasions, but as it is possible that many intending constructors may not have the issues in which these are described, and there may be some difficulty in obtaining them under present conditions, I have thought it advisable to give further details, specially applicable to the engine now under discussion.

In order to turn the cam flanks, it is necessary to set the shaft up in the lathe, eccentric to the shaft axis, the throw being determined by the radius of the arc which forms the flank. Referring to Fig. 68, it will be seen that this dimension is $\frac{7}{8}$ in., but this is taken from the tangent line of the base circle, which is 7/16 in. dia. (7/32 in. radius), and thus the eccentric throw, measured from the shaft centre, is ($\frac{7}{8}$ in. − 7/32 in.) = 21/32 in. In this case the throw is the same for both the inlet and exhaust cams the difference in their opening periods being obtained by varying the radius of the nose. Any method whereby the shaft can be offset parallel to the lathe centre to the required extent, and adjusted for angle by turning on its own axis, will enable the cam flanks to be shaped by an ordinary cylindrical turning process, but the use of a simple jig such as that shown in Fig. 70, will not only facilitate setting up, but also ensure accuracy in the angular setting of the cams.

This jig is simpler to construct than those previously described, and the method of applying the division plate also simplifies its use. It consists principally of two cheeks or "throw plates" attached to a turned mandrel which can be run between the lathe centres, and holds the shaft rigidly parallel to the latter. No precise dimensions are given except the specified throw radius, as the jig can be made of whatever material happens to be available, and any suitable method of attaching the cheeks to the mandrel, or clamping the shaft in them, may be adopted. The use of split clamps, with the bolts intersecting the mandrel as shown, is, however, recommended, as it precludes the possibility of either cheek shifting round so as to throw the camshaft out of parallel alignment with the mandrel. It would, in fact, be an advantage to clamp the camshaft by somewhat similar means, as there is a possibility that the set-screws might bruise the finished journal surface of the camshaft, but I have found the method shown quite satisfactory if brass set-screws, with dead flat ends, are employed, and discretion exercised in screwing them up.

The division plate used is about $2\frac{1}{2}$ in. dia., made of sheet brass or other suitable material, and is marked out carefully to correspond with the angles shown in the right-hand diagram in Fig. 67. This is attached to the side of one of the cheeks by a single countersunk screw, with its centre hole in exact alignment with the shaft hole in the cheek; a piece of rod 5/16-in. dia. may be used as a dowel for lining it up. A hole must be drilled in the plate, in line with the centre of the mandrel to clear the nose of the lathe centre, when the jig is mounted up for use. It will be noted that the division plate is inverted in relation to the diagram in Fig. 67; the reason is a purely utilitarian one, as it avoids having to bring the index pointer into such a position that it would foul the lathe centres. The index, it will be seen, consists of a radial arm with a centre boss bored to fit the gearwheel seating of the camshaft, and clearly marked with a zero mark. An alternative method would be to use the gearwheel itself, with a pointer clamped to it in a position coinciding with the top dead centre position; but it is quite likely that the timing gears may not be available when the camshaft is made; and some

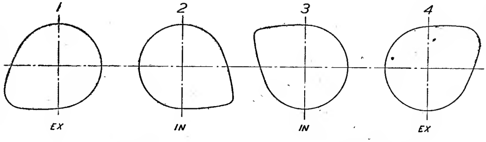


Fig. 69. Relative positions of the four cams when crank is at top dead centre.

* *Continued from page* 211, "*M.E.*," *Sept.* 11, 1941.

modification would have to be made in the method of mounting the division plate, to avoid fouling the back face of the wheel.

It may be observed that this jig makes no special provision for locating the top dead centre position of the camshaft, which is useful, though not absolutely essential, for initial location when timing the shaft up on assembly. A rough check on this may, however, be made when the shaft is mounted up in the jig, and the pointer clamped to it, by setting the latter at " TDC 2 " (marked O2 in Fig. 70). The jig is now rotated in the lathe, and a tool fed up to the relieved centre portion of the shaft, so as to just mark the surface ; the centre of this mark is then centre-punched.

Machining the Cam Flanks

To proceed with the cutting of the cams ; suppose we start with No. 1 cam, which is an exhaust cam, and thus the pointer may be set either to E.O. or E.C.—it is immaterial which of the two flanks of the cam is machined first. Select a keen lathe tool with plenty of top rake ; I prefer one with a rounded nose, as this enables a good finish to be produced on the cam. Set this opposite to No. 1 cam blank and feed it in until it just tips the surface of the blank as the jig revolves. It is now necessary to provide some means of measuring the depth of cut which must be taken—namely, 3/32 in.—as direct measurement after cutting is somewhat difficult. If the cross slide screw is equipped with an index this will be a simple matter, as all that is necessary is to add 0.093 in. to the initial setting, and cut each cam flank to exactly this depth. Another very simple method, if one possesses a 2-in. micrometer or a good vernier slide gauge, is to measure over the outside edge of the cam blank and the mandrel, for the initial setting, and deduct 3/32 in. from this figure for the final measurement.

Having cut the first flank by easy stages, and produced a good tool finish, loosen the shaft set-screws and turn the pointer to the other exhaust marking, re-tighten the set-screws, then repeat the procedure *on the same blank*. Shift the slide rest to work on the next cam (No. 2), and take cuts in exactly the same way with the pointer set at I.O. and I.C. respectively.

It is now necessary to shift the index pointer to 180 deg. on the camshaft. To do this, the shaft set-screws should be loosened, and the pointer first turned to O2 ; then the set-screws are firmly tightened, the end nut of the camshaft slackened and the pointer prised off. The utmost care must be taken not to turn the shaft during this operation, and I suggest, therefore, that the jig should be removed from the lathe centres and the shaft held in the vice by the uncut blanks, using copper clamps to avoid marking them. The pointer is then replaced on the camshaft, but this time pointing to O, and again firmly fixed by tightening the end nut. Now proceed to turn the flanks on the remaining cam blanks by the same methods as before. Do not forget that No. 3 cam is an inlet cam, not an exhaust cam ; it is so easy to make errors like this, which result in ruining the camshaft completely. The greatest care should be observed in setting the pointer to the markings on the division plate in every case, and in taking all cuts to exactly the same depth.

Forming the Base Circle

When the cam flanks have been formed, there will be quite a lot of superfluous metal left between them, which must be reduced down to the radius of the base circle. This may be carried out in any convenient way, the most efficient method being by circular milling, but care must be taken not to run into the flanks at either end of the cut, after so much pains have been taken to form them accurately. A safer way is to carry on with the turning operations, shifting the shaft each time until all the unwanted metal is removed. If a sufficient number of cuts are taken, all to the same original depth setting, hardly any further work on the base circle will be necessary. Yet another method is to use a filing rest in the lathe ; the one described some months ago in THE MODEL ENGINEER by " Ned " is particularly suited to this purpose, as it is equipped with a micrometer height adjustment which allows the base circle to be finished to very close limits of accuracy. I favour the use of a filing process for finishing, as it reduces the liability of damaging the flank curves, and enables the base circle to be very slightly reduced to allow tappet clearance. No particulars are shown on the drawing to indicate the tappet clearance, as I have found from previous experience that it tends to confuse inexperienced constructors. It is quite permissible to use the cams without making special provision foi tappet clearance ; the only difference it will make is the loss of a few thousandths of an inch of valve lift and a reduction of the angle of opening by one or two degrees. But for the utmost efficiency, it is advisable to reduce the radius of the base

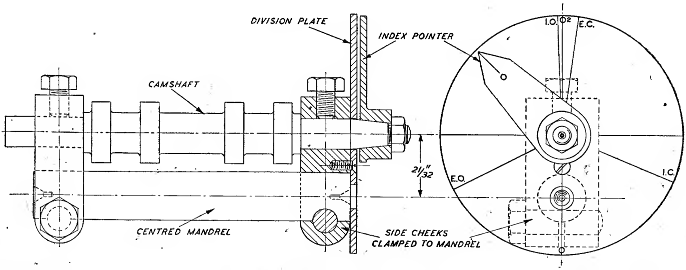


Fig. 70. Camshaft set up in jig for turning flank contours.

circle about four or five thousandths of an inch, which will provide sufficient tappet clearance, and enable full valve lift and period to be maintained. At the beginning of the flank curves, the base circle should be eased up, so that there is no abrupt change of contour.

A precaution which is strongly advised, in order to avoid unfortunate accidents, is to mark the tip of each cam as soon as the two flank curves have been formed, by means of a spot of bright-coloured, quick-drying paint. This ensures against the possibility of making a mistake, during the removal of unwanted material from the base circle, which might result in removing the very part of the cam that matters.

Nose Contour

It remains now to finish the nose of each cam to a smooth circular arc, which joins the flank curves without removing anything measurable from the extreme tip. I have not been able to find any better method of doing this than by hand filing, using an improvised radius gauge made from sheet steel as a guide. A very smooth file should be used for finishing, and the entire cam surface should be polished to remove all tool marks and scratches before hardening.

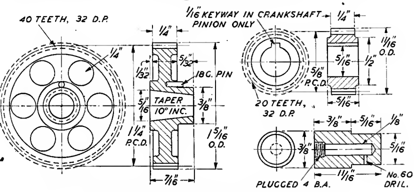


Fig. 71. Details of timing gears (1 off each part, extra pinion without keyway used as idler) and idler pinion stud.

Hardening the Cams

If the cams are made separately to the shaft, they should be threaded on a 5/16-in. bolt for case-hardening; in this way the bore and end faces of the cams are kept soft, and also protected from scaling. When the camshaft is made in one piece, the working surfaces of the cams are the only portions which must necessarily be hardened, though it is an advantage to have the journals hardened as well; but all other parts may with advantage be left soft. In production practice, the accepted method of doing this is by leaving an allowance, deeper than the penetration of the hard "case," on these parts, and machining them to size after carburising, but before quenching out. The same methods may be applied in the present instance if desired; an alternative method is to apply some form of coating locally, to prevent the case-hardening composition coming into contact with the steel at these points. Various substances are often recommended for this purpose, but the only really reliable method that I can personally recommend is to copper-plate the parts, or otherwise shield them by *metal* casings. The particular advantage of leaving the parts between the cams soft is that it enables the shaft to be straightened if it becomes distorted in hardening, without risk of starting surface cracks.

In order to minimise risk of distortion, a means of quenching out which works as nearly simultaneously on all parts of the shaft as possible should be adopted. Special quenching tanks fitted with convergent water jets are often employed to this end, but as they are hardly likely to be available, the next best method is to set up a miniature "whirlpool" by vigorously stirring up the water, and plunge the shaft vertically into the centre of the vortex. After hardening, check the shaft between centres and correct any distortion detected; this operation calls for patience and quite a fair skill in the use of a lever and a lead hammer. It may be observed that different steels vary considerably in their susceptibility to distortion when heated and quenched, but as most of us will have to put up with what material we can get these days, there is little point in making recommendations for the selection of suitable steel, beyond mentioning that black mild steel is better than most kinds of bright rolled steel in this respect, and special case-hardening steels, such as Ubas or S14, are better still.

Timing Gears

Particulars of the spur gearing employed for driving the camshaft are given in Fig. 71. It comprises a spur gear, 1¼ in. pitch circle diameter, attached to the end of the camshaft, a pinion of ⅝ in. pitch circle diameter keyed to the crankshaft, and an intermediate or idler pinion between the two. The size or number of teeth of the latter do not affect the gear ratio of the train, but as a matter of convenience, it is specified as identical in size to the pinion on the crankshaft, and set on the centre line connecting the latter with the camshaft spur gear. This point is mentioned because, if it should happen that gears differing from the above specification, but providing the essential two-to-one reduction, happen to be available, it may be possible to make use of them; discrepancies in the gear centre measurements being compensated by using an idler gear of the appropriate diameter, or offsetting the latter from the centre line of the gear train.

With reference to the supply of ready-made gears for this engine, it is admitted that gears are always a source of a certain amount of uneasiness, even in normal times, because of the difficulty of obtaining them ready made, or of ensuring that such gears as are offered for sale by advertisers are of the correct specification, and up to the standard of accuracy required. I can assure readers that I have gone to considerable pains in the past to obtain the co-operation of the trade in these matters, but it has been extremely difficult to convince traders that it is worth their while to consider these, and other, special requirements of the amateur constructor.

For this reason, I have made a point of reducing the gearing on this particular model to the bare essential minimum; but as everyone will agree, one cannot very well do without timing gears in an orthodox type of four-stroke engine. I am, therefore, making these gears as simple and straightforward as possible, with a view not only to simplifying the difficulties of the trader who may be prepared to undertake the supply of ready-made gears, but also those of the constructor who may essay to tackle the gearcutting problem himself. And so, while hoping that it will be possible to ensure that those who wish to buy gears may do so, I trust that in the event of failure in this respect, readers will not consider that the construction of the engine is thereby rendered impossible.

As a matter of fact, the task of cutting simple spur gears in the lathe is by no means as formidable as some readers seem to think, and in practically every case where it has been tackled with patience and determination, it has been brought to a successful conclusion. It is not necessary to

use expensive or elaborate apparatus for the job, as all the gear required can be made up by the amateur constructor on the lathe to which it is to be attached. I have on many occasions had to make up gearwheels for my own experimental models, and quite apart from the question of economy, I have generally found the results to be more satisfactory than those obtained with gears made to order by professional gearcutters. This statement is not intended as a reflection on the competence of those who undertake such work, but it is often difficult for them to understand the exact requirements of the customer, or to fulfil them at a reasonable price.

One of the constructors of "1831" has recently tackled the gearcutting problem, and has produced some excellent spur gears at the first shot. I have persuaded him to furnish a complete description of his methods—which are in many respects novel and original—for the benefit of other readers, and it is not necessary for me to pursue the matter further at present. I may mention, however, that the same constructor is also helping me to solve the more difficult problem of cutting the skew gears which will be required for the transmission system of "1831," and it is hoped that a method of doing so which is within the capabilities of most amateurs will eventually be evolved.

Spur Wheel

To return to the specification of the gearing, the most suitable pitch is 32 D.P., which gives 40 teeth on the camshaft spur wheel, and 20 on each of the pinions. Other pitches are possible, but if the respective pitch diameters specified are adhered to, they will necessarily involve some multiple of five teeth in the pinion and ten in the spur wheel; for example, 15 and 30 teeth (24 D.P.), or 25 and 50 teeth (40 D.P.). The material used for the gears admits of some latitude, but the principle of using dissimilar metals for adjacent gears is advised. As the tooth loading is quite moderate, brass is quite a satisfactory metal for the large spur gear. It should be noted that if the forced lubrication system recommended for this engine is employed, a second spur gear of identical size and tooth specification to that of the camshaft gear will be required. The recessing and drilling of this gear are optional features, but are recommended. If the tapered bore of the boss is accurately machined to fit the camshaft, no key will be required, and I am in favour of omitting the key, on the principle that "slip is preferable to shear" if one has to choose between mechanical breakdowns. I am aware that the fitting of a key on a properly fitted cone shaft should eliminate both risks; but experience has taught me that the presence of a key often provides a pretext for slipshod fitting, as the careless constructor believes—sometimes erroneously—that the key will maintain a positive drive whatever happens. It should be noted that if a key is fitted, its position should be exactly ascertained after timing up the gears, as the oblique location of the gear train makes it difficult to set the position of the key by angular measurement. When ready-made gears have to be bored to fit the shaft, the greatest care should be taken to set them up absolutely true with the teeth, and the use of a "clock" or other form of test indicator is strongly advised to assist in ensuring this.

The projecting end of the wheel boss is turned down to ⅜ in. dia., and it will be seen that a small dowel pin is driven into the face of the gear, projecting about 1/16 in. or so. These provisions are arranged for the fitting of the ignition distributor. It is convenient, but not absolutely essential, to fit the pin so that it comes uppermost at T.D.C. When the spur gear has been fitted to the shaft and timed in conformity with the engine timing diagram, it should be clamped firmly by the nut on the end of the shaft, and the gear train may be punch-marked to denote the adjacent teeth of all three gears, diametrically-opposite teeth of the idler being marked so that no confusion over the two marks will arise.

Pinions

It will be seen that the crankshaft pinion and the idler pinion are identical in specification except that no keyway is required in the latter. Both these gears may be made of mild steel, and in order to fulfil the condition of "dissimilar metals in contact," one of them may be case-hardened. This should, preferably, be the idler. The crankshaft pinion should be a very close push fit or a light tapping fit, on the shaft, and the key should be fitted to preclude any possibility of side play, but it should not bear hard top and bottom. Care should also be taken to see that the gear is firmly clamped endwise against the shoulder of the shaft when the contact-breaker cam is assembled and the starting dog screwed home.

The bore of the idler pinion should be smoothly finished, as it forms a bearing surface. It has not been considered worth while to bush the pinion, owing to its limited size, but as an alternative to the arrangement shown it might be made a press fit on a short 5/16 in. shaft, and the latter run in a bush pressed into the face of the main casting. The form of stud shown is, however, simpler and will be quite satisfactory; if the idler pinion is case-hardened all over, there is no need to harden the stud.

It will be seen, by reference to the detail drawing of the main casting (Fig. 43, May 22nd issue), that a ⅜ in. hole is bored in the timing face to take the idler gear stud. The position of this hole is of great importance to ensure proper meshing of the gears, but it is readily verified by measurement from the centres of both the crankshaft and the camshaft. In the event of error in its position, the idler stud may be made eccentric to provide compensating adjustment.

The lubrication of a wheel running at high speed on a stationary stud sometimes presents a difficult problem, which can only be satisfactorily solved by introducing oil from inside the pin. This provision is made in the idler stud, but some mystery may arise from the fact that no entry passage for oil is shown, and the end of the stud is plugged. It will be seen, however, that if the main casting is drilled for the lubrication of the main bearings, the hole for the timing end bearing will cut into the idler stud and furnish a direct supply under pressure. If, however, forced lubrication is not fitted, the inner top corner of the stud may be bevelled off, and a countersunk gravity oil well drilled in it.

(To be continued)

CLEANING A MICROMETER

After using a micrometer it is advisable to see that no minute particle of dirt remains on the contact faces when it is returned to zero, or they may be damaged, or the instrument strained in the screw and nut. The quickest and most certain way to clean them is by closing the micrometer on a piece of clean paper and drawing it through; any dirt will become embedded in the paper and be withdrawn.

If the locking-ring of a micrometer caliper spindle refuses to tighten, it should on no account be rapped or forced. The reason is the entry of dirt, and flooding with paraffin or petrol will set it in working order again.—A.J.T.E.

★ The Construction of A Reflecting TELESCOPE

By W. E. Moorhouse, A.M.I.M.E.

TO secure the mirror housing to the barrel, the latter requires four pieces of angle fixed to it, one on each side, in the centre, exactly opposite the lugs on the steel plate, on the housing. Diagram 8 (*a*) shows how this is done, whilst Diagram 8 (*b*) gives details of the angle pieces. Diagram 8 (*a*) also shows details of a slot cut in the centre of each side of the barrel, to allow the mirror housing to slot into the barrel. When this has been done, the housing may be secured to the barrel by means of $\frac{1}{4}$-in. diameter bolts, each ·3 in. long, as pictured in Diagram 9, each bolt having three nuts. Care should be taken to get bolts which are threaded up to the bolthead. Thus, by slackening

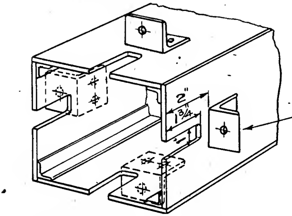


Diagram 8 (a). Angles for holding mirror housing.

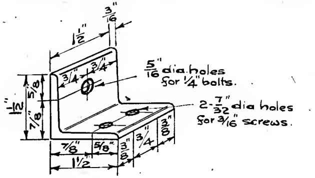


Diagram 8 (b). Detail of mild steel angles (4 required).

one nut, and tightening others, a complete adjustment is obtainable.

The mirror housing should now be dismantled from the barrel, and put carefully on one side, when we can turn our attention to the other end of the barrel. This other end has to house two things, firstly the small flat mirror, usually called the *flat*, and bought with the large mirror, and secondly, the eyepiece mounting. To consider the housing of the flat, Diagram 10 shows the complete housing, and from this I will describe each component part. The flat mirror should be about $1\frac{1}{2}$ in. diameter, and will be cut at an angle of 45°. To hold the flat, two pieces of copper tubing are required, one piece $1\frac{1}{4}$ in. outside diameter, and the other $1\frac{1}{4}$ in. bore. Each tube should be roughly 16 gauge thick; that is, about 1/16 in., and 3 in. long. One end of each tube should be cut at an angle of exactly 45°. The $1\frac{1}{4}$ in. outside diameter tube should now have its other end cut off square, so that it measured $1\frac{3}{4}$ in. long at the shortest point. The other tube also requires its other end cutting off square, but this tube requires to be slightly longer. The length of this tube at the shortest point should be $1\frac{3}{4}$ in., plus the depth of the flat mirror, when measured on the edge. Diagram 11 (*a*) will make this clear. For those who prefer it, a circular piece of wood may be substituted for the $1\frac{1}{4}$-in. outside diameter tube. The dimensions will remain as before. Two small pieces of copper plate are now required, shaped as shown in Diagram 11 (*b*), and fastened to the larger tube by means of a $\frac{1}{8}$-in. Whitworth setscrew, $\frac{1}{4}$ in. long. These pieces of bent plate serve to hold the flat mirror in position. A piece of flat copper plate is now required, $\frac{1}{8}$-in. thick, which requires shaping as shown in Diagram 12. After shaping, it should be brazed or soldered, centrally to the base of the larger copper tube, see Diagram 13. We now have to consider the adjustment of this small flat mirror, and this can only be done by suspending it from the sides of the

* *Continued from page* 232, "*M.E.*," *September* 18, 1941.

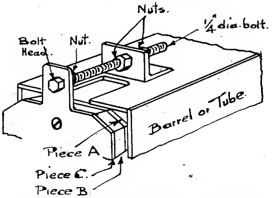


Diagram 9. Mirror housing secured to barrel.

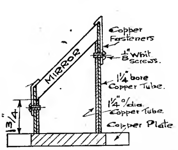


Diagram 10. Complete housing for flat mirror.

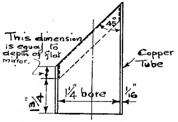


Diagram 11 (a). Detail of copper tube.

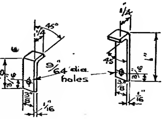


Diagram 11 (b). Details of bent copper plate.

barrel. It should be borne in mind that any obstruction in the barrel will stop light rays from reaching the reflecting mirror, and to overcome this, I find the best method of suspending the flat mirror is by means of spring steel, which, when on edge, will not interfere appreciably with these light rays. This spring steel should be about $\frac{1}{4}$ in. wide, and an old clock spring will be found very suitable. If one is not available at home, no doubt the local clock repairer will sell one for a few coppers, as even a broken

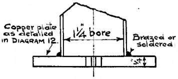


Diagram 13. Copper plate brazed to tube.

one will do. Having obtained the spring, four pieces are required, each 2$\frac{7}{8}$ in. long, a hole 9/64 in. diameter should be drilled $\frac{1}{4}$ in. from each end, as shown in Diagram 14. This will be done quite easily if the ends of the spring are held in the flame of a match until the spring turns blue, which has the effect of softening the steel. The housing is completed by means of four special bolts, which are detailed in Diagram 15. These may be turned in a lathe from $\frac{3}{8}$-in. square bar, or, still using $\frac{3}{8}$-in. square bar, by

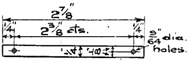


Diagram 14. Spring steel suspenders (4 required).

screwing one end as shown, to $\frac{3}{8}$ in. Whitworth. If the square edges are first taken off by filing, the screwing will be much easier. A 9/64-in. hole should be drilled in the square end, and a notch cut $\frac{3}{4}$ in. deep with the hacksaw, as shown in Diagram 15. These bolts, when in use, will tighten the springs, and owing to the strain imposed on the sides of the barrel, I suggest we fix four plates, one on each side, to take this strain. Diagram 16 gives details of these

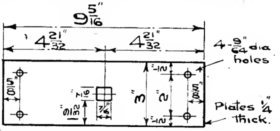


Diagram 16. Detail of mild steel plates (4 required).

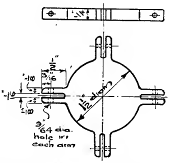


Diagram 12. Detail of copper plate.

plates, which should be fastened through the five-ply wood, to the corner angles by means of $\frac{1}{8}$-in. Whitworth bolts. Diagram 17 shows these plates in position, and the distance from the end of the barrel. When this has been done, square holes should be made in the wood, corresponding with the square holes in the plates. This may be done by drilling a $\frac{3}{8}$-in. diameter hole in the wood (with the plates in position) and filing square. This com-

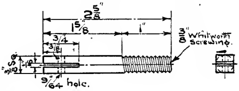


Diagram 15. Detail of tightening bolts (4 required).

pletes the housing for the flat mirror, which may now be assembled as follows, but without the flat mirror itself. Take the tubes, to which has been brazed the flat copper plate, and bolt one piece of spring steel to each arm by means of $\frac{1}{8}$-in. Whitworth bolts and nuts. The spring steel will, of course, fit into the slot made by the hacksaw. Screw a nut on the end of one of the square-ended bolts

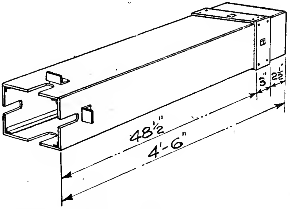


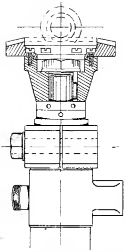
Diagram 17. Mild steel plates in position on barrel.

(Diagram 15), and place the square end into the square hole in one of the steel plates secured to the barrel. Put the tubes, now with the four pieces of spring steel attached, inside the barrel, from the end, and secure the end of the springs to the square bolts by means of $\frac{1}{8}$-in. bolt and nut as before, when the housing is complete.

(To be continued)

Modifications to a Milling Attachment

By Ian Bradley



Sketch showing method of mounting crown wheel and adapter on milling attachment.

IN a previous issue I described a milling set-up that has proved of great use in end-milling operations. Recently, however, having had occasion to make some small gear wheels which were wanted for a particular purpose, the milling set-up has undergone some structural alterations (or perhaps I should say additions, as the basis of the rig remains the same) so that gear-cutting could be carried out.

In making the additions I have deliberately so arranged matters that the set-up can be reinstated for plain end-milling by simply removing one sub-assembly and replacing a pulley, thus getting rid of the tedious business of undoing a mass of nuts and fixings.

Now, in order successfully to carry out this light gear-cutting, the first essential was to reduce the spindle speed by driving through a reduction gear, so a hunt round for some suitable gears was made. After turning over all the odd ones in my possession, it seemed that I had really drawn a blank until an old drilling machine was spotted in one of the workshop junk boxes. This drill was one of those self-feeding affairs made popular by the French some few years ago, and this particular sample must have been about the smallest ever produced, as its maximum capacity was only 3/16 in. However, there it was, and, moreover, it possessed a bevel gear and crown wheel (quite decently made, for a wonder) which would give me a reduction of approximately 3 : 1.

Useful Parts

I stripped the machine out, and whilst doing so realised that quite a number of the other parts could be worked into the scheme for providing the necessary reduction gear for the milling spindle ; for example, the flywheel fitted to the machine could be made into a V-pulley for driving purposes, whilst the main frame would provide a satisfactory and quickly detachable sub-assembly in which to mount the bevel gear shaft.

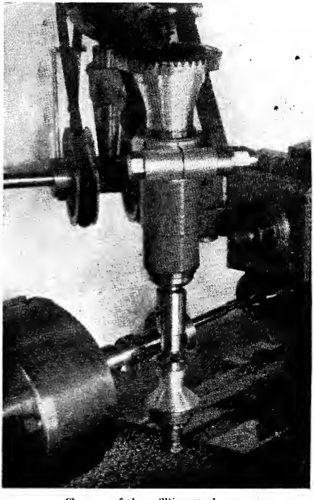
The size of the spindle (5/16 in. diameter) fitted to the drilling machine was felt to be a little too small to use as the bevel shaft, and so a new shaft ⅜ in. diameter was decided upon. This decision got over one difficulty as regards the bevel itself, namely that it had originally been bored oversize on 5/16 in. diameter so that it should slide freely on its spindle, the drive being taken up by a circular key, semi-circular slots being formed in the gear and spindle to accommodate the key.

The main frame of the drilling machine is fitted with three bearings, one long bearing about 9/16 in. diameter carrying the flywheel stub shaft and two bearings 5/16 in. diameter supporting the drill spindle. The spindle and flywheel of the drilling machine are not rigidly connected, the flywheel being driven through a thrust race from the spindle which enters the flywheel stub shaft and is screwed loosely into it.

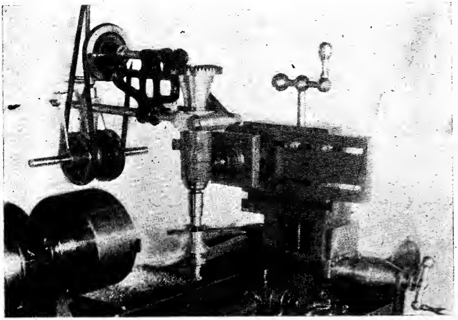
A rough check up showed that the aforementioned three bearings were anything but in line ; they were, in fact, whole fractions of an inch adrift, so a start was made in putting this matter right. I decided to do away with the centre bearing, but as it was desirable to retain the centre-bearing lug, this would be bored clear of the shaft.

One or two tentative efforts to bore out these bearings in true axial alignment soon proved that there was only one way to do the job, namely to mount the casting on a stub mandrel pressed into the flywheel shaft bearing, centre the mandrel accurately in a chuck and D-bit the other two bearings out to 7/16 in. diameter. This would leave the centre bearing clear of the shaft and enable a bronze bush to be fitted to the other bearing housing for carrying the bevel gear end of the drive shaft.

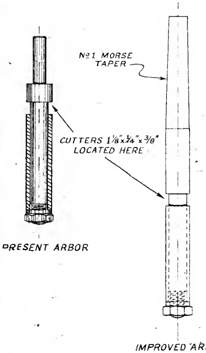
Great care was necessary in setting the D-bit accurately, but once it was started, the whole job became plain sailing and, as a proof of the accuracy of the method, when the time came to assemble things the shaft fitted into the flywheel and ran truly without rock or stiffness.



Close-up of the milling attachment.



The complete rig-up.



I have said that the centre bearing lug was retained. The reason for this was the fact that the lug carried a 5/16-in. pin set at right-angles to the drive shaft centre line. This pin provided a suitable anchorage for a ⅜ in. × 5/16 in. tie-bar, the other end of which is made fast to the clamp which secures the whole driving assembly to the head of the milling spindle.

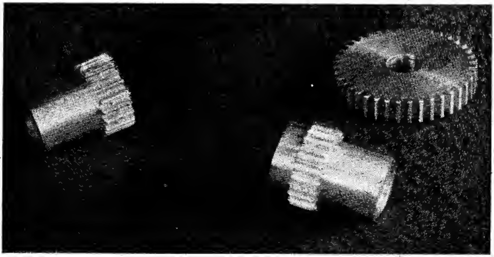
Now with regard to the bevel drive shaft itself; this shaft, being ⅜ in. diameter, has one end turned down to take the bevel gear as a tight push fit. The gear seats against a square shoulder and is secured against rotation on the shaft by developing in the latter, the other half of a semi-circular sectioned keyway formed in the gear (this is accomplished by drilling, but in order to start it nicely the end of the shaft should lie about 1/16 in. below the outer face of the gear. If this point is attended to, no trouble will be experienced in picking up the keyway). A key is then pressed into the hole and a keep, in the form of a 3 B.A. screw and washer, fitted to the end of the shaft.

The next job tackled was the mounting of the crown wheel on its adapter. A section of the arrangement is shown, as this may possibly be of assistance to those wishing to make up similar equipment. The crown wheel was caught in the independent 4-jaw chuck and, after centring accurately so that the gear teeth ran truly in both planes, was bored out to 1 in. diameter (this size enables one to get a box-spanner on to the milling spindle nut). The underside of the wheel was now faced and a spigot formed to engage with the register in the adapter.

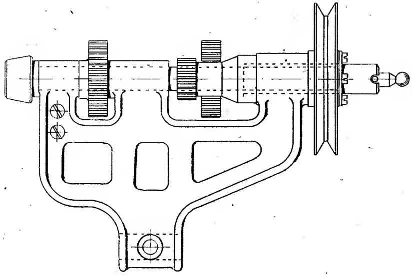
The crown wheel is secured to its adapter by six No. 6 B.A. cheese-head screws. I should have preferred something a little larger, but there was not room for bigger screws. However, the 6 B.A. screws take the drive all right.

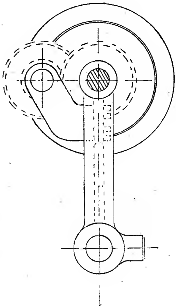
I found the best method of gauging the exact dimensions for the adapter so as to get accurate tooth engagement was to place a pile of ½-in. washers over the milling spindle and resting on the lock-ring, adding further washers until, when the crown wheel was placed on top of the washers and the bevel wheel brought into contact with the crown wheel, the meshing was found to be just right. The pile of washers was then measured with a micrometer, the result being the overall height of the adapter.

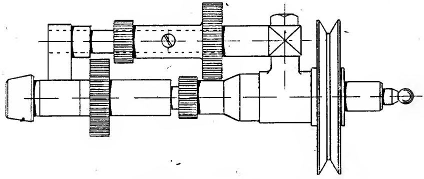
In order to permit the new ⅜-in. drive shaft to enter the old drilling machine flywheel stub shaft, the latter was bored and reamed ⅜ in., and at the same setting modification of the flywheel so as to convert it into a V-pulley was carried out. The drive shaft is secured against rotation in the flywheel by a taper pin.



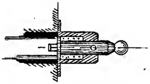
Some of the work turned out. Gear-wheels for "1831."







Three views, showing the general arrangement of back-gear.



View, in section, to show direct-drive locking device.

So far as the actual machining was concerned, this completed the operations ; assembly was, therefore, carried out, and a test run proved that the machine ran smoothly and quietly.

Having finished the drive unit, an arbor to carry the milling cutters had to be made. Incidentally, the cutters themselves had also to be made, in view of the impossibility of getting any commercial cutters to-day, I propose to touch on this matter of cutter production at a later date.

As to the arbor, this was made to fit the existing end-mill adapter which leaves the drive end of the arbor somewhat on the small side ($\frac{1}{4}$ in. diameter), though no trouble on this score has been experienced as yet. A sketch of this arbor and of one which is being made to replace it is given herewith.

It was thought desirable for a steady bearing to be applied to the outer end of the cutter arbor, and results have fully justified the application. The steady takes the form of a stay (in this case a bicycle crank) bolted to the saddle and fitted with a bronze bush. It will be noticed that the lower end of the cutter arbor has a conical aluminium " Umbrella " attached. The purpose of this fitting is to protect the steady bearing from the ingress of swarf. Practical tests with the milling attachment have fully justified the work involved and will provide gear-cutting facilities for any purpose that is likely to be met with in the home workshop.

The combination of a dividing-head and this milling attachment, when used in conjunction with other apparatus, is the subject of a provisional patent.

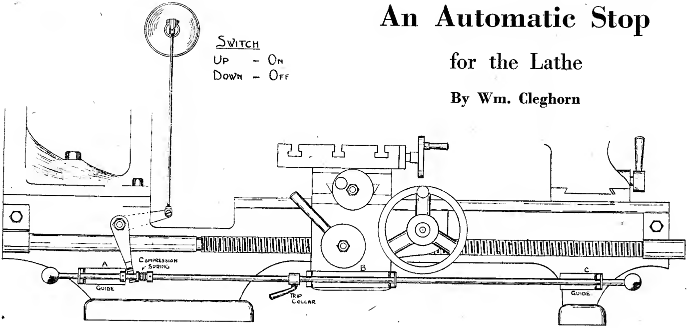
A Back-Gear

Since these notes were written, a back-gear for this milling attachment has been completed, the gears for the job being cut with the attachment itself. This refinement is well worth while, as it very materially facilitates gear-cutting in steel. The overall reduction with the backgear in is 12 : 1. I am showing a general arrangement of this addition, but have purposely not given any detail drawings, as these will in all probability not be of much use to other constructors unless, which is somewhat unlikely, they possess an identical old drilling machine to that which was converted in this instance. However, if the details are wanted, they can be had.

An Automatic Stop

for the Lathe

By Wm. Cleghorn



THE automatic stop described below was, at first, paradoxical though it may sound, not intended to be one. It was merely desired as a remote control for the motor-switch to obviate leaning over the lathe when switching on or off, a proceeding which may be dangerous to one's skin or clothing when a sharp corner of the work in hand is projecting beyond the chuck or faceplate. The reader will, at this juncture, remark, why not move the switch to a position of greater safety? This solution, besides being too obvious and easy, would not properly meet the case, as there would still be a stretch if the switch were placed at either end of the plate; for it is a long-bed model, and it could not be placed underneath at the centre because of drawers in the bench upon which it stands. It was, therefore, decided upon that the best way would be to put a spindle through the lathe headstock casting, and this spindle, by means of suitable levers, would operate the switch. The long, $\frac{1}{4}$-in. diameter, steel push-rod which makes the stop automatic was not added until a Drummond $3\frac{1}{2}$-in. lathe had been examined closely and the advantages of an automatic stop were fully appreciated. This rod, the fitting of which entails only a small amount of extra work, was soon added, and now gives, in addition to automatic control, instant hand control from any position on the lathe-bed. The ends of the push-rod may be finished off with small red fibre knobs as shown, or they may be left plain for the sake of simplicity.

Drilling the lathe-bed is not recommended if it can possibly be avoided. An alternative method would be to carry the lever-spindle in brackets clipped to the bed; drilling, however, although it is likely to weaken the lathe slightly, makes the attachment an integral part of the machine, and consequently less inclined to become displaced and cause any trouble. The rocking-shaft carrying the levers is a piece of 5/16-in. B.D.M.S., and passes through two 5/16-in. holes *in line* with each other. Care must be taken over the drilling of these holes, and their position placed so that they do not weaken the lathe unduly; any ribs in the casting should be carefully avoided.

The switch in use happened, fortunately, to be a Crabtree 5-amp. tumbler-switch which had once formed half of a two-pole main-switch of the type not often seen in these days of ironclad and bakelite main-switches. In this type there were two tumbler-switches, side by side, having their knobs connected together by means of a wooden or ebonite bar, the knobs being drilled and tapped (6 B.A. in this case) for attachment of the bar. It will be seen that a switch of this type lends itself readily to modification, and the attaching of levers or links is greatly facilitated. In the arrangement shown, a small fork-end is fastened to the switch-knob, a tie-rod from this leading down to the back-lever. The tie-rod referred to was only used to evade the trouble of moving the switch and altering the existing wiring; a much better arrangement would be to have the switch mounted immediately behind the lathe-bed so that it could be operated directly by the back-lever, thereby dispensing with the tie-rod.

The two brackets supporting the ends of the push-rod, and also the centre-piece attached to the saddle, are made from 3/16 in. by $\frac{3}{4}$-in. flat mild steel bar. Each bracket is held in its place by means of two No. 2 B.A. steel setscrews screwed into the lathe-bed; the brackets are made in such a manner that the push-rod may be instantly detached when not required or to give accessibility for cleaning purposes. This detachment is achieved by slotting the holes which carry the rod and fitting a small hook, made from 1/16 in. sheet mild steel, to each bracket; these hooks, three in all, retain the push-rod in its working position.

When considering the fitting of the push-rod, the writer was at first inclined to be doubtful concerning the effect which the momentum of the rotating parts of the lathe would have upon stopping, instantly, the movement of the saddle. To make certain, several tests were made, during which the travel after switching-off was never in excess of 1/16 in. This was with the normal set of change-wheels in use for giving a fine self-acting feed of approximately 154-t.p.i. When cutting coarser threads, and with the back-gear in use, the travel may, possibly, exceed this very slightly, and will, of course, have to be allowed for when setting the trip-collar. A small compression spring is fitted to the push-rod at the point where it engages the forked lever. This spring is intended to impart a little resilience

(*Continued on page* 259)

Small Capstan Lathe Tools

Notes on "tooling up" for repetition work, with special application to the small capstan attachment recently described in the "M.E."

By "Ned"

IN the description of the capstan attachment for a 3 in. lathe, which was published in the issues of the "M.E." dated from April 15th to May 10th last, the subject of cutting tools for use with this appliance was briefly referred to, and it was suggested that, if there was found to be a general demand for further information on the subject, it would be discussed in detail in a later series of articles. As several readers have asked that this should be done, the following notes have been prepared, and it is hoped that they will be found useful, not only to users of the particular attachment referred to, but also to all readers who are faced with repetition tooling problems on light capstan lathes.

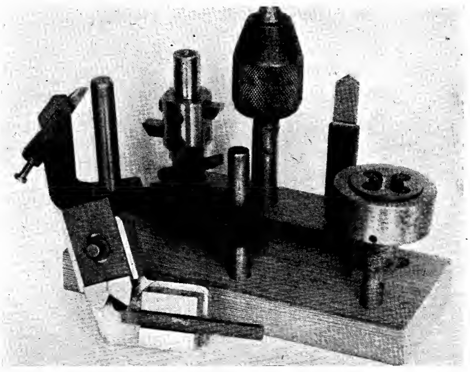
The subject of capstan lathe tools has already been dealt with fairly completely, in a series of articles entitled, "Capstan and Turret Lathes," which was published about eighteen months ago in the "M.E."; and the information given therein has been republished in the form of a practical handbook bearing the same title.

This contains information on practically all standard types of repetition tools, and the principles of operation hold good, whether the lathe on which they are used is simple or complex; but in many cases the tools used on modern production lathes are of a very elaborate and expensive nature, justified by the requirements of intensive quantity production, but quite out of place in the more modest production schemes likely to be encountered by readers of this journal. This applies particularly in the case of "adapted" lathes, or capstan lathes of a primitive type. It is proposed, therefore, to show how the desired results may be obtained with quite simple forms of tools and tool holders, such as can be made up fairly easily, and as occasion requires, to suit the work in hand. Such tools do not necessarily impose any practical disadvantages if discreetly applied, and may be used for work demanding the highest accuracy; neither do they restrict rate of output to any serious extent, except on work which calls for a very high cutting efficiency. Such work, however, is hardly within the scope of the "adapted" lathes with which we are mainly concerned.

It is just as well here to point out that whereas it is necessary, for the utmost efficiency in quantity output, to use machines which are capable of high spindle speeds and heavy cuts, the advantages of these features do not always weigh very heavily when light components, which do not entail the removal of a great deal of metal, are being produced. In such cases, the general handiness of the tool layout is the more important feature, and speaking from experience, it is quite possible to produce such parts as small terminal studs and nuts, ferrules, nipples, union nuts, etc., on a light adapted lathe, at a rate which is by no means incomparable with that attained by a specially-equipped factory lathe.

Motions Required

In the present case, it is assumed that the lathe to be tooled up is equipped with a six-station revolving turret, having stops for limiting the travel of each individual tool, and a cross-slide fitted with front and rear tool-posts, and at least one end stop, for limiting the depth of cut is one of these tools. With regard to these tool-posts, it is suggested that something of the nature of the type illustrated in the issue of July 10th, by Mr. Ian Bradley, should be employed. Two of these, attached directly to the lathe cross-slide by bolts in the appropriate tee-slots of the latter, enable front and rear tools to be carried, and provide the utmost rigidity. In some cases it may be found necessary to fit the top swivelling slide, to deal with work which calls for taper turning, but the majority of small capstan operations can be managed without it, and its removal is an advantage. Longitudinal adjustment of the saddle is also unnecessary in most cases, and it may be locked to the lathe bed by tightening up the slide adjusting gib screws. A very sound rule in small repetition work is to elimi-



A group of tools suitable for use on a light capstan lathe or capstan attachment.

nate unwanted movements and adjustments, as they only complicate operation; but it is important that slides which are not in use should be firmly locked against inadvertent movement, or they may introduce errors in the work. If full advantage is to be taken of the principle of "automatic accuracy," which is the most important consideration in any machine tool used for quantity production, every tool-slide in use must necessarily be equipped with some form of locating stop or registering device to ensure that the tool finishes its motion at exactly the right position.

Tool Steels

It is very often thought that capstan lathe work demands the use of special high-speed steels and cutting alloys. This question is, however, inter-related with the matter of spindle speeds and cutting rates, which we have considered above. If it is allowed that useful work can be done without forcing the speed or the cut to the utmost, then it is fairly obvious that it can also be accomplished without the aid of special tool steels either. It is, however, desirable to take all reasonable steps to ensure that the tools work under the most favourable conditions, and well within the limits of their endurance. Heavy cuts should always be taken with roughing tools, which should be capable of standing up to a fair amount of heat, and the finishing tools should be as hard as possible, and required to take only light cuts. The popular tool holder bits, made of such high-speed steels as "Bullet," "Stag Major," "Toledo," "Eclipse," and so on, will give good results on most materials likely to be handled in the home workshop, including medium alloy steels. But in cases where these are unobtainable, quite good work can be and has been done on small capstan lathes with carbon steel tools, particularly in machining brass and aluminium alloy components. Silver steel bits are particularly suited for taking finishing cuts, as they can be tempered to a high degree of hardness without risk of the edges chipping, and thus wear longer than most ordinary high-speed steels so long as they are not overheated or overloaded. The facility with which such bits can be made is also an important consideration, and round silver steel rod is easily the handiest material for making up such tools as flat drills, sizing cutters, D-bits, etc.

It is proposed to classify the various tools used on capstan lathes in the order corresponding, more or less, to the normal sequence of operations on which they are used. In order to give a comprehensive explanation of general procedure, reference will be made to all the tools used in a complete operation, whether they are cutting tools in the true sense or not. Finally, some examples will be given of typical light capstan operations to illustrate the application of appropriate tooling systems.

The "Drudgery" of Repetition Work

Until about two years ago, the question of repetition work in any shape or form might have been considered entirely outside the concern of model engineers, and, indeed, there are some readers, even at the present time, who may feel almost insulted at the suggestion that they should undertake work of this nature. Model engineering being primarily a pastime and a recreation, the prospect of turning out numbers of parts, all as much alike as so many peas, may sound anything but inviting. But quite apart from the fact that war conditions have forced upon many readers the necessity of regarding their workshop as a means of helping the nation, rather than of satisfying their own creative instincts, it is quite possible to apply repetition principles, with advantage, directly to model engineering workshop practice. Every model engineer has at some time or other experienced difficulty, or even a complete hold-up, due to the lack of some particular type of bolt, nut, rivet or other standard part, which has not been commercially available in the exact specification required. Many readers have solved the problem by making the required items one at a time by the usual individual or "one-off" methods; but while some of them may regard it as a matter of principle to adhere to these methods, it is by no means certain that the extra speed and efficiency of repetition methods would entail less interest, or be incompatible with the spirit of model engineering.

Repetition work is very commonly regarded as drudgery, but this idea is to a great extent associated, not so much with processes as with numbers. The idea of making large quantities of simple and more or less uninteresting parts is related to the prosaic tasks of washing up so many dishes, or hoeing so many rows of turnips; but, allowing that such tasks are necessary, surely the logical thing is to find ways and means of speeding them up, and reducing the number of manual manipulative motions required for dealing with each individual part. Work in which one is really interested never becomes irksome, and drudgery can only exist if it is encouraged by the mental attitude which regards work merely as a sordid means to a prosaic end. As a matter of fact, there is quite a fascination in carrying out any process efficiently, and this applies in no small measure to the operation of a small capstan lathe. To see each tool carrying out its allotted task with speed and precision, and to know that each part made fulfils a vital, even though perhaps a minor, purpose in the assembly to which it contributes, are sources of pleasure and satisfaction which every true engineer can fully appreciate.

(To be continued)

For the Bookshelf

Machine Shop Practice. By W.C. Durney, A.M.I.Mech.E. London: Sir Isaac Pitman & Sons Ltd. 7s. 6d. net.

In any machine shop production job the sequence of the cutting operations in the lathe or other machine tool is of importance for two reasons. In the first place it affects both the convenience and accuracy with which the work can be accomplished, and secondly it affects the time taken to do the job, a not unimportant consideration in these days when rapid production is essential. This question of operational sequence is a distinguishing feature of Mr. Durney's book, and in the various examples of turning, shaping and milling he has selected for treatment, he not only explains the technical details of the tools and machining processes involved, but clearly sets out the order in which the various portions should be machined, and the reasons for this procedure. This course is also adopted in an excellent chapter on exercises in fitting and gauge and tool making. The book has been designed for the use of Ministry of Labour trainees, apprentices, and students, and will amply repay a careful study of its well-chosen series of representative jobs, which are all in keeping with modern workshop practice. The large number of sketches and dimensioned drawings add much to the value of the book, and instructors in training centres might well consult its pages for beneficial examples of work for their pupils to undertake, or for subjects for detailed exposition at lecture times.

★ Model Aeronautics

A General Purpose Duration Aeroplane

By Lawrence H. Sparey

HAVING finished the primary structure of the fuselage, there remains a good deal of work in the shape of the various fittings. In the first place, the nose of the machine must be strengthened by the addition of strip balsa, fixed as a panelling between the stringers of the first bay. This will be seen in the picture, Fig. 9. If balsa stringers have been used, it will be necessary to have ⅛-in. sheet balsa for the panelling, whereas 1/16-in. balsa will be thick enough for use with birch or spruce stringers. Each of these panels will have to be individually shaped and fitted between each pair of stringers, and the best way to do this is to cut 18 pieces of the sheet to a size slightly larger than the finished panels. One edge of each piece should be straight. The panel is then inserted into the fuselage through the nose opening, and the straight edge pressed firmly against one stringer. With a sharp-pointed pencil pressed hard against the opposite stringer, a line is drawn on the balsa, and the rough panel withdrawn. Now, with a razor blade, cut the panel to shape, leaving it full by cutting on the outside of the pencil line. The panels may be cut to length afterwards, when they have been cemented into the fuselage.

In addition to the nose panelling, similar pieces of balsa will be required for the undercarriage-fixing. The two lower ones will be seen in Fig. 9, marked (A), and it will be noted that a small piece is cut from one corner. It is in this opening that the undercarriage leg is located. These pieces of balsa are cemented between stringers Nos. 12 and 13 on one side, and Nos. 7 and 8 on the other. On the top of the fuselage, between stringers 18, 1 and 2, other pieces of balsa are cemented, and may be seen marked (X) in Fig. 10. A glance at Fig. 11 will show the purpose of these balsa inserts. This is a drawing of the undercarriage system. It will be understood that the balsa insert (A) on the lower stringers acts as a bearing in which the undercarriage leg swings. Its action is checked, however, by a tightly stretched rubber band, which is fixed through a hole in the top of the leg, and through a hole in the top balsa panel, where it is secured by a small wooden peg. The action should be readily understood from the drawing, especially as the contrivance is quite clearly seen in the photograph, Fig. 9. Further details of the undercarriage legs will follow, but I may state that this is one of the simplest and most efficient type of sprung undercarriage which I have yet encountered.

* *Continued from page* 219, "*M.E.*," *September* 11, 1941.

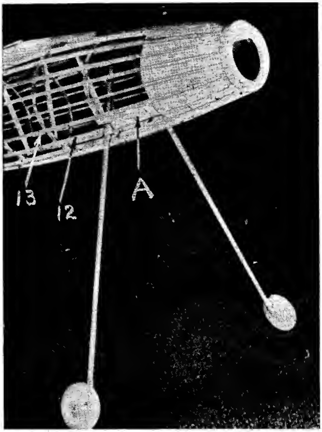


Fig. 9. Details of fuselage and undercarriage construction.

A further glance at our useful photograph, Fig. 9, will show the nose former, of ⅛-in. balsa, which is cemented to the front of the fuselage. A drawing is given in Fig. 12, and it will be noted that the opening is cut as part of a circle, with a straight portion left along the top. Later, the nose block of the machine will be shaped to fit into this opening, when the straight portion will prevent the block from turning. The easiest way to make the nose former is to cut the opening in a roughly-shaped piece of balsa, and cement it centrally over the nose of the fuselage. The outside may then be cut and sanded to conform to the shape of the fuselage.

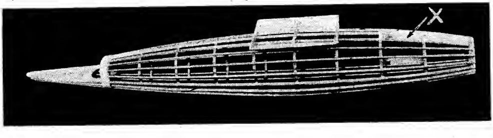


Fig. 10. Partly finished fuselage.

Wing Mounting Platform

In the machine under consideration, the main plane is located upon a small platform, thus imparting a parasol arrangement to the design, and, incidentally, providing a particularly inconspicuous wing fixing system, by means of rubber bands. Figure 13 shows the construction of this platform, and it will be noted that the main supports consist of three pieces of 1/16-in.

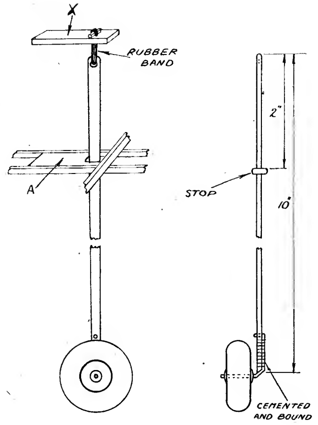


Fig. 11.

balsa, shaped as shown in Fig. 14. The photograph shows the position in which the platform is cemented to the body. First cut the three supports, and cement them to the appropriate stringers. Before the cement is set, the tops of the supports should be lined up by the eye, by glancing along them from the front of the machine, and ensuring that the tops of the supports all lie along the same horizontal line. Now, let the cement set, and then cement on the side pieces. These may be of 1/32-in. sheet balsa. Although not shown in the photograph (as it was desired to expose the structure), the top of the platform is sheeted in with 1/16-in. balsa.

Tail Platform

The photograph, Fig. 15, gives a good idea of the manner in which the tail end of the fuselage is finished off, and of the tail plane seating. It will be remembered that in the construction of the fuselage, former No. 10 was made much wider than the others. This was done in order to provide a strong housing for the bamboo peg which secures the rubber motor at the rear end. Small pieces of ⅛-in. balsa are used to fill in the spaces between the stringers directly over former No. 10. They are then sanded flush, as may be seen in the picture, and a 3/16-in. hole bored, from side to side, directly above stringers Nos. 14 and 6. The rubber motor is held by a bamboo peg which is a tight push fit in the 3/16-in. holes.

This being completed, the top stringers are cut through directly behind former No. 10, leaving stringers Nos. 14 and 6, and all those which lie below them, intact. The top half of the rear of the fuselage may then be removed by cutting through former No. 11 with a razor blade. The platform may then be sheeted over with 1/16-in. balsa, in which a semi-circle is cut at the front end, to provide

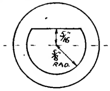


Fig. 12.

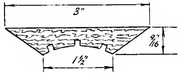


Fig. 14.

easy access to the rubber peg. When the sides of the platform have been sanded flush with the fuselage line, two runners, of 1/16-in. × 3/32-in. balsa (or 1/16-in. × 1/16-in. spruce) are cemented along the edges, for a distance of 3 in. These form locating guides for the tail plane unit. All these details are very clearly shown in Fig. 15.

A further tail-fixing detail is provided by the small wire hook shown at the tail end of the fuselage. This is secured to a small bamboo peg, one end of which is sharpened to a point, pushed between the stringers at the rear end, and cemented. The hook, which may be formed from a pin, is cemented to the protruding portion of the peg, and bound with a thin strip of wetted, gummed-paper tape, as may be seen at (A) in Fig. 15.

Undercarriage Legs, etc.

The diagram, Fig. 11, gives these details. The legs are formed from bamboo splits, ¼ in. wide and ⅛ in. thick, which are slightly tapered towards the tips. A similar section of birch may be used if the bamboo is not available. At the top end, a small hole is bored for the reception of the

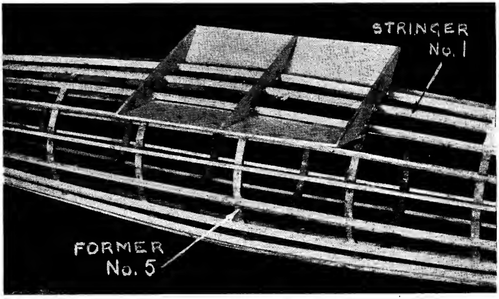


Fig. 13. The wing platform.

rubber spring device, and it will be found the easiest method to burn these holes out with a red-hot wire. There is then no danger of splitting the wood. Two inches from the top of the leg, a stop is provided, and this may be done by winding on several turns of wetted, gummed-paper strip. As I have mentioned before, when dry, this paper strip becomes as hard and solid as wood, and may be used for a variety of purposes in model construction.

Owing to the possible difficulty in obtaining them, I have not specified balsa wheels, but have used hardwood wheels of 1½-in. diameter, which may either be purchased, or may be turned by those with a lathe. Very high speed is required, using a sharp tool with a heavy top rake, forming a pronounced lip. Hardwood wheels will require no bushing, but may run direct on the spindles, which are bent to the shape shown, from 16 S.W.G. pinao wire. One end forms the wheel spindle, while the other end is bent at a right-angle, and embedded in a hole (similarly burnt out with a hot wire) in the undercarriage leg. This will prevent the wheels from swivelling on the legs. Wheels are secured to the spindles by collet washers, which are soldered into place. The joint between the leg and the spindle wire should be flooded with cellulose cement and bound with a strip of wetted gum-paper tape.

To assemble the legs into the fuselage the following method was adopted. First, the small rubber bands were pushed into the holes at the top of the legs. The free ends of the rubber band were then tied to a length of thread, which was threaded on to a long darning needle. The needle was then pushed through the hole in (A) and out at the hole in (X), Fig. 11. Then, by pulling the thread, the leg was pulled into position, and the rubber band stretched through the hole in (X), when it was secured by the small bamboo peg. When the legs are in position in the fuselage, it will be necessary to bend the wire wheel spindles to a slight angle, so that the wheels will assume a vertical position.

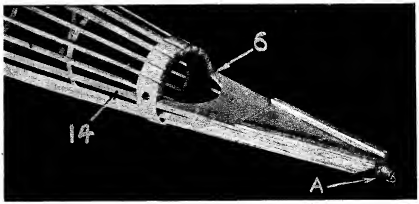


Fig. 15. Construction of the tail of fuselage.

(To be continued)

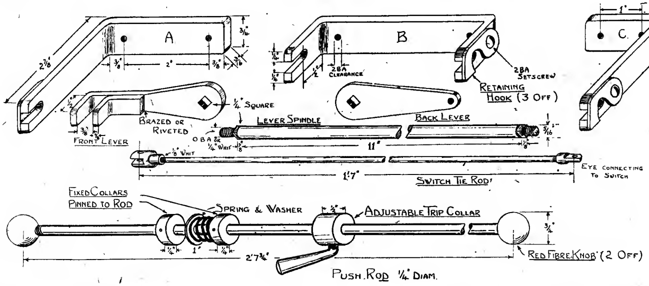
An Automatic Stop for the Lathe

(Continued from page 254)

to the motion, and also to avoid any damage likely to be caused by the aforesaid momentum.

To refer to the sketch for a moment, it may be advisable to point out that the dimensions given are only meant for general guidance, as every attachment likely to be made will vary according to the type of lathe to which it is applied, and also to each individual maker's ideas upon the subject. There is hardly any need for further remarks upon the construction, and the writer claims no originality for the idea, as it was probably invented by Mr. Heath Robinson many years ago.

The writer is of the opinion that a device such as the one described, which switches off the "juice" and so stops the lathe completely, is an improvement upon those automatic stops which throw out a clutch and merely stop the movement of the saddle, as in the latter case the tool is left rubbing against the revolving work to the detriment of its edge. This is only an expression of opinion, and must not be taken as a gauntlet thrown down as a challenge to debate the merits and demerits of automatic stops.



Letters

Steam Cars

DEAR SIR,—I was interested to see from Mr. Newbery's etter, in your September 4th issue, that there are still a few enthusiasts who sigh for the return of sooted-up burners, burnt-out tubes, leaking glands, and other forms of entertainment that seemed generally to accompany steam car motoring in the days when such contraptions were in use.

Does he honestly think that, given a free hand, he could produce a steam car to better the results given by the present-day petrol counterpart? If so it would be of great interest to know how he proposes to overcome the numerous objections which finally killed steam cars over 30 years ago, although petrol was still comparatively crude and unreliable.

The subject is particularly interesting to me at the moment as I lately obtained a large number of issues of the "English Mechanic and World of Science," dated 1905 and 1906, in which the steam *v.* petrol war appears to have been fought out with great thoroughness, a certain Mr. David J. Smith, and one or two others, vigorously championing steam against all comers.

I wonder if Mr. Smith is still with us, and if so, does he still use a steamer?

Yours faithfully,

Norwich. "STORMY PETREL."

Lathe Design

DEAR SIR,—There have, in the past, been discussions upon lathe design, the ultimate aim being the evolution of the ideal lathe for the model engineer. Now, although this subject has cropped up several times in the past, there have been no actual concrete or, perhaps I should say, iron and steel results. The object of this letter is to try to revive the discussion in order to arrive at the above-mentioned results. I feel that if some of the well-known experts (I name two only, "Mr. Westbury and 'L.B.S.C.'") would come forward with their views in such a way that a design could be built up, we would be very far along the road of attainment.

I feel that we should forget accepted practice and originate something to fill our own needs. Before anything can be put on paper, there are some points which need to be cleared up. For instance, a large variation in mandrel speeds is almost a necessity, and yet to accommodate a reasonably large size of draw-in collet the mandrel must be large with consequently hefty bearings, an asset at low speeds and heavy cuts, but what about the higher speeds; in fact the whole machine must be solid and firm, and yet sensitive to the operator. It appears to be generally agreed that a large slotted cross slide with a good long traverse is very desirable, and to my mind auto traverse then becomes more than desirable.

Back gear or some form of purchase we must have; also, screwcutting gear, but I do not agree that it is necessary to be able to cut a great variety of pitches. I should think half a dozen pitches, with a good slow self-act would be ample; they could always be added to if desired.

The long slotted boring table would be very useful for milling; well, why not give it vertical feed motion also? It is my opinion that all these points can be settled by careful design, that is where the experts should help. "L.B.S.C." has hinted that he has something of the sort up his sleeve—how about lugging it out, it ought to be good.

I want to get patterns made up ready for an immediate start when the present spot of bother is cleared up, but before preparing my design I would like to hear other suggestions—two heads, etc., etc. I believe the worker in the smaller sizes is well catered for, but when one gets on to something a bit larger, the faults of the average amateur lathe very soon make themselves felt; they seem to me to be altogether too skimpy.

The modern tendency is one machine one job I know, but space and funds do not always run to this ideal; and here we all agree, I think, that the model engineer is not out for quantity production, but for quality. I hope you will see your way clear to encourage discussion on this most interesting matter.

Yours faithfully,

West Wickham. R.V.B.

Where Does the Energy Go?

DEAR SIR,—I have been interested in a recent letter discussing how the energy spent in winding up a spring reappears if the spring is subsequently placed in acid and allowed to corrode away.

The conclusion reached, viz., that the energy spent in winding the spring up reappeared in the form of additional heat generated due to the high rate at which the particles fly off has led me to ponder on the possibility of increasing the heat given off by my coal ration this winter if I carried the coal upstairs and had the fire there.

Unfortunately, my house is only a bungalow, so I cannot carry out the experiment, but I am passing it on for what it is worth.

I am inclined to agree that a certain amount of heat would be "generated" in getting a ton of coal upstairs, but what I am anxious about is the recovery in the form of heat the foot pounds spent in raising the coal.

Yours faithfully,

Rosyth. "DRUMACRIEVE."

P.S.—One other tip—if you cut your own firewood it will heat you twice!

Miniature Racing Cars

DEAR SIR,—Happening to pick up a copy of your interesting paper recently I was most interested to read the letter from Mr. Curwen regarding his model petrol-driven car.

As a model railway fan of some years standing, I had turned my attention to model cars shortly before war broke out, and built an experimental rubber-driven car with the intention of progressing to power-driven jobs, but circumstances prevented this.

I would be most interested to hear from Mr. Curwen and know more about his car; also, others that any reader might have built. Would it not be possible for you to devote a little more and regular space to this comparatively new phase of model engineering?

Yours faithfully,

O.A.S. EDWARD M. HUNTER.

NOTICES

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Matters intended for publication should be clearly written, and should invariably bear the sender's name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

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